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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

APR 10 1995

Mr. Jack Wilson, Director
Division of Water
Natural Resources and Environmental
Protection Cabinet
Dept. for Environmental Protection
14 Reilly Road
Frankfort, KY 40601

Dear Mr. Wilson:

I am pleased to inform you of the U.S. Environmental Protection Agency's approval of the Total Maximum Daily Load (TMDL) for Harrods Creek in Oldham and Jefferson Counties. The TMDL/Water Quality Strategy recommends elimination of all small wastewater treatment plants discharging to lower Harrods Creek and those discharging above Sleepy Hollow Lake. Wastewater in lower Harrods Creek will be routed to the regional Morris Forman plant on the Ohio River and wastewater plants above Sleepy Hollow Lake will be routed to the regional advanced waste treatment facility located on Hite Creek.

We are approving the TMDL as being in full compliance with Section 303(d) of the Clean Water Act, which requires that TMDLs be established at levels necessary to implement the applicable water quality standards.

We commend the Division of Water in its efforts to develop a TMDL strategy for Harrods Creek. We look forward to working with the Division in future TMDL efforts. For your information, we have enclosed a fact sheet which summarizes the information and strategy contained in this TMDL. If you have any questions regarding this action, please ask your staff to call Virginia Buff at (404) 347-2126 ext. 6602.

Sincerely yours,

Robert F. McGhee
Acting Director
Water Management Division

Enclosure

cc: David Leist

Harrods Creek TMDL Fact Sheet

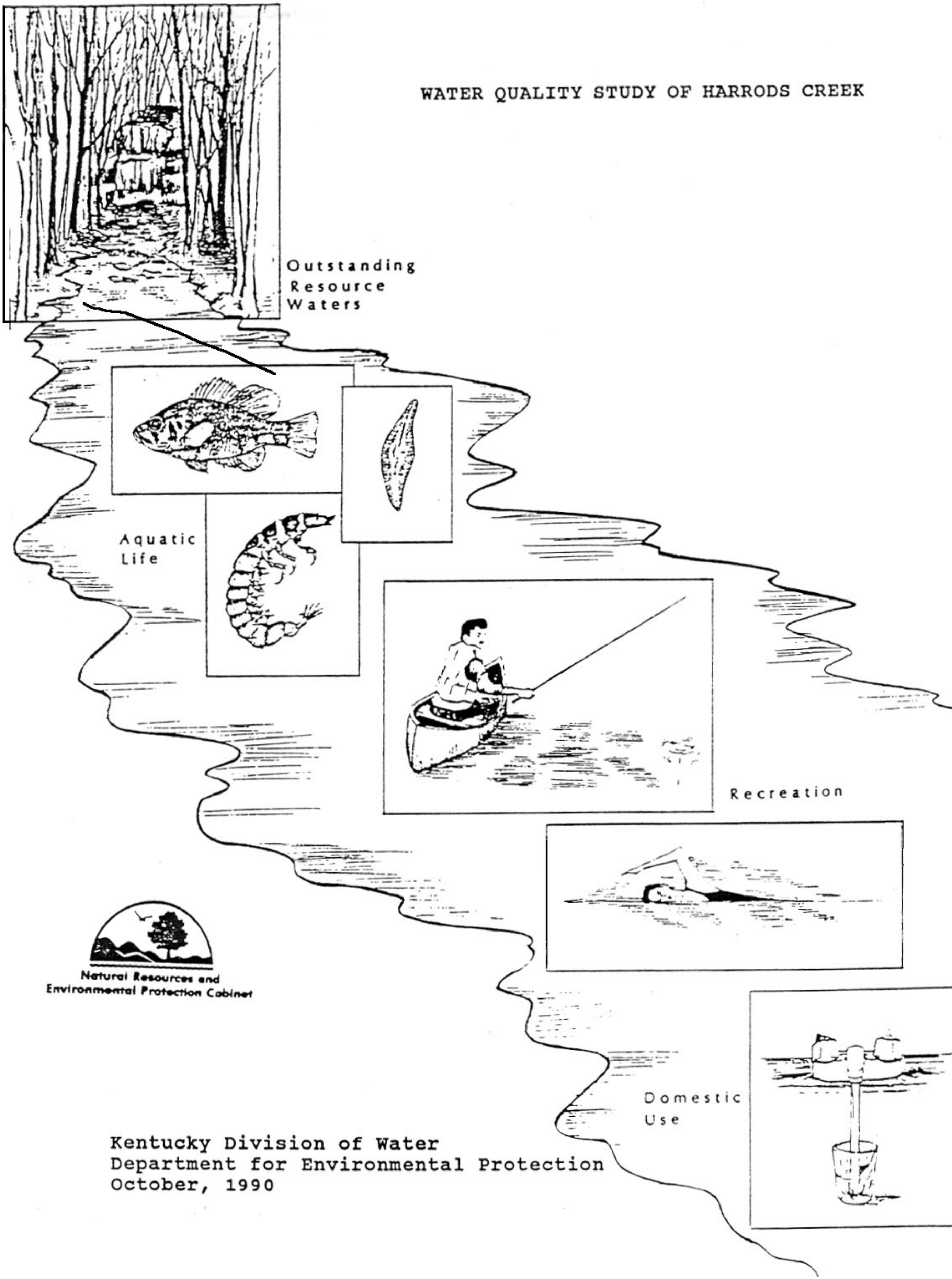
Project Name:	Harrods Creek Dissolved Oxygen TMDL
Location:	Oldham and Jefferson Counties, Kentucky
Scope/Size:	River mile point 7.5 to mile point 0 of Harrods Creek which flows into the Ohio River. Due to downstream dams and locks in the Ohio River water in Harrods Creek will slow down or reverse (backwater).
TMDL Issues:	Point Source
Data Sources:	Ambient monitoring and 1990 water quality survey
Data Mechanism:	KY QUAL2E predictive modeling and in-stream monitoring
Control Measures:	KPDES Permits
Summary:	In 1990 KY DOW collected water quality data on Harrods Creek to examine D.O. from mile point (MP) 0 to MP 12. Of primary concern is the backwater area (MP 0 to MP 4.2) where a D.O. sag below the D.O. standard was measured for nearly 3 miles. Eight package plants in or near the backwater area contribute oxygen consuming constituents, BOD5 and ammonia, to Harrods Creek. Predictive model runs showed that if these 8 small plants are removed from lower Harrods Creek, D.O. will be maintained at the 5.0 mg/l standard. The model run and survey showed that the critical condition for D.O. is during high temperatures (summer) and low flow conditions. Also, a number of small package plants discharging above Sleepy Hollow Lake will be removed.
TMDL Development:	The TMDL strategy calls for elimination of the 8 package plants in the backwater area of Harrods Creek. Flows will be sent to a regional plant located on the Ohio River in another basin. Wastewater plants upstream from Sleepy Hollow Lake have also been recommended for removal. Flows from these plants will be rerouted to the Hite Creek regional plant. KY QUAL2E modeling predicts that the in-stream D.O. standard will be maintained at effluent limits of CBOD5 = 10 mg/l, NH3-N = 2 mg/l and D.O. = 7 mg/l for the Hite Creek plant and no discharge allowed from the other 8 backwater plants and the plants upstream from Sleepy Hollow Lake.

Implementation Controls:

The facility owners with plants in or near the backwater area of Harrods Creek have already been contacted and informed that their current NPDES permits will not be renewed. Existing permits will expire in mid-1998.

Monitoring of Harrods Creek is planned after removal of the dischargers. Based on that information it will be determined if additional point source or non-point source controls are needed.

WATER QUALITY STUDY OF HARRODS CREEK



Natural Resources and
Environmental Protection Cabinet

Kentucky Division of Water
Department for Environmental Protection
October, 1990

WATER QUALITY STUDY OF HARRODS CREEK

KENTUCKY DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
WATER QUALITY BRANCH

Frankfort, Kentucky

This report has been approved for release:

Jack A. Wilson

Jack A. Wilson, Director
Division of Water

12-7-90

Date

WATER QUALITY STUDY OF HARRODS CREEK

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Division of Water

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Introduction

Harrods Creek begins in Henry County and flows 31 miles through Oldham and Jefferson Counties to its confluence with the Ohio River above Louisville. Along its route are areas of Oldham and Jefferson County that have experienced rapid growth, and new development is under construction. Much of the watershed is not served by a centralized sewage disposal system; instead package systems have been installed to meet the waste disposal needs of individual developments.

In 1987, the Division of Water (Division) became concerned about water quality conditions in Harrods Creek, particularly the lower four miles which are in backwater from the Ohio River. The u.s. Geological Survey(USGS) responded to a request to conduct streamflow measurements throughout the basin, and much lower flows were measured than were expected. In 1988, these lower flows were incorporated in the QUAL2E water quality computer model, which then predicted that lower Harrods Creek did not meet Kentucky's dissolved oxygen (DO)standard of 5.0 milligrams per liter (mg/L) .Also in 1988, the Metropolitan Sewer District (MSD), in cooperation with the USGS, began a stream sampling program throughout Jefferson County. Measurements made by these agencies showed that dissolved oxygen standards were not being met at their station on Harrods Creek, located 3.2 miles upstream of the Ohio River.

The Division, in an effort to improve water quality conditions in Harrods Creek, began requiring more strict effluent limits from existing wastewater facilities, denying construction of new package wastewater facilities, and supporting MSD's North County Action Plan. This plan will extend sewer lines into the area, eliminating existing wastewater facilities. In order to accommodate ongoing development, the Division has approved expansion of the three facilities owned by the City of Prospect. The expanded facilities will have stricter permit limits than their current requirements, with a theoretical net reduction of pollutant loadings into the stream. In addition, the Division committed to conduct a water quality survey of Harrods Creek during critical low flow conditions to verify the low DO levels predicted by the QUAL2E model and previous sampling. Although originally scheduled for the summer of 1989, stream flow did not reach the desired low-flow conditions, and the study was delayed. Conditions in 1990 were more representative, and the study was conducted on July 10 and 11. This report presents the results of the study.

Description of Study Area

Harrods Creek drains 108 square miles of Henry, Oldham, and Jefferson Counties. Major tributaries are Ash Run, Brush Creek, Cedar Creek, Darby Creek, and South Fork Harrods Creek. Stream slopes are moderate to flat: about 15 feet per mile from the headwater to mile 15 above Darby Creek; about 10 feet per mile to mile 7.5 above South Fork Harrods Creek; about 5 feet per mile to mile 4.2, and virtually no slope in the lower 4.2 miles, which is in backwater from the Ohio River. The backwater is greater than 50 feet wide and 15 feet deep in places. Water elevation in this area is controlled by the pool stage of the Ohio, which in turn is controlled by the McAlpine Lock and Dam at Louisville. There are 33 active wastewater facilities in the basin, which include schools, small industrial plants, residential subdivisions, and MSD's Hite Creek regional facility. Location of wastewater facilities are noted on Figure 1 and described in Table 1.

Water quality sampling was conducted in the lower half of the basin because this is the area of most concern. The study area begins at the confluence of Darby Creek with Harrods Creek (milepoint 12) and extends to the Ohio River. The section from Darby Creek to mile 4.2 is a pool and riffle reach. Pools are 40 to 60 feet wide and 1 to 2 feet deep in places, with short narrow riffles separating them. Location of sampling sites are also noted on Figure 1, and described in Table 2.

Fig. 1. Harrods Creek basin

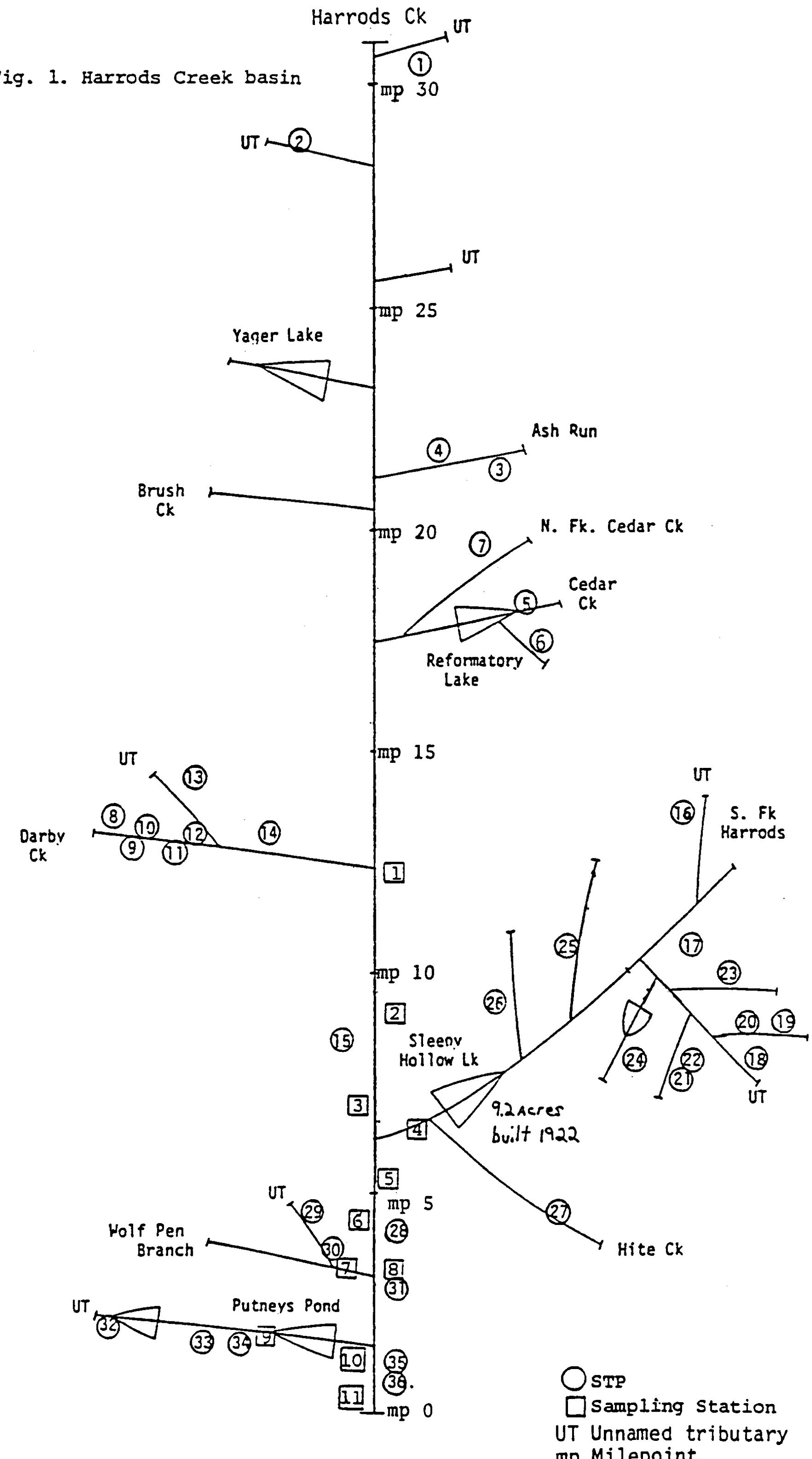


TABLE 1. WASTEWATER FACILITIES IN THE HARRODS CREEK BASIN

MAP #	NAME	DESIGN FLOW (MGD)*
1	LAKE JERRICO VE14EER	0.005
2	STUCKY'S RESTAURANT	0.029
3	ANAMAG	0.005
4	OLDHAM WOODS SUBDIV	0.178
5	CLAYTON AND LAMBERT	0.025
6	DISCONTINUED	
7	KY DOJ REFORMATORY	0.650
8	OLDHAM COUNTY H.S.	0.015
9	OLDHAM CO JR HIGH	0.007
10	OLDHAM CO VOCATIONAL	0.003
11	OLDHAM CO MIDDLE SCH	0.012
12	HEATHER HILL SUBDIV	0.070
13	MOCKINGBIRD VALLEY SUB.	0.040
15	PARAMONT SUBDIVISION	0.400
16	PARKLAKE ESTATES	0.075
17	GULF SER. STA. KY 329	0.001
18	SOUTH OLDHAM MID. SCHOOL	0.030
19	CRESTVIEW APTS #1	0.002
20	EDGEWOOD APARTMENTS	0.002
21	SUNOCO SERV. STATION	0.001
22	THRESCO	0.005
23	SUBURBAN PARK SUBDIV	0.060
24	CRESTWOOD PLAZA APTS	0.065
25	ORCHARD GRASS SUBDIV	0.300
26	WILLOW CREEK SUBDIV	0.150
27	M.S.D. (HITE CREEK)	4.000
28	PROSPECT (HUNTING CK SOUTH)	0.251
29	PRIVATE HOME	0.001
30	PRIVATE HOME	0.001
31	TIMBERLAKE SUBDIVISION	0.200
32	COVERED BRIDGE SUBDIV 001	0.040
33	COUNTRYSIDE ESTATE SUB.	0.065
34	PROSPECT, HUNT. CK NORTH	0.350
35	M.S.D. (KEN CARLA SD)	0.010
36	SHADOW WOOD SUEDVISION	0.085
	TOTAL DESIGN FLOW	7.133

*MOST FACILITIES OPERATE AT LESS THAN DESIGN FLOWS

Table 2. Location of Water Quality Sampling Stations

Station #	Description
1	Harrods Creek at Highway 1694 bridge, milepoint 12.3
2	Harrods Creek above Paramont Estates Subdivision STP, milepoint 8.9
3	Harrods Creek at Highway 329 bridge, milepoint 6.9
4	South Fork Harrods Creek at Highway 1694 bridge, milepoint 1.4
5	Harrods Creek at edge of backwater area, milepoint 4.2
6	Harrods Creek above Hunting Creek South STP and milepoint 3.6
7	Wolf Pen Branch at mouth
8	Harrods Creek above Timberlake STP, below Wolf Pen Branch, at milepoint 2.6
9	Unnamed tributary above Putney's Pond, milepoint 0.60
10	Harrods Creek at Highway 42 bridge, milepoint 1.5
11	Harrods Creek near mouth, milepoint 0.20

Data Collection

Water quality samples were collected at 11 stream stations and the outfalls from Paramont Estates-,, Hunting Creek South, and Timberlake wastewater facilities during relatively low-flow conditions on July 10 and 11, 1990. Weather conditions on July 10 were hot and sunny, with air temperatures exceeding 95°F. July 11 was overcast, with air temperatures about 82°F. In addition to these samples, instantaneous measurements for dissolved oxygen and temperature were made at numerous locations and depths in the study area using Yellow Springs Instrument meters. Dissolved oxygen and temperature were also measured hourly for 24 hours at four locations in Harrods Creek using Hydrolab automatic data sonde units. These units were placed in Harrods Creek on July 10 and 11 at mile 3.6 (above Hunting Creek South STP), mile 3.3 (below Hunting Creek South), mile 2.2 (below Timberlake STP), and mile 1.5 at the Highway 42 bridge. Units were placed at a depth of about 4 feet. All field meters were calibrated on-site, while the sonde units were calibrated in the office the day prior to deployment. Check measurements using the Winkler titration method were done periodically to ensure meter accuracy. Water samples were collected mid- channel about 2 feet deep by boat in the backwater areas and by wading in the upstream areas.

Although conditions for this study were considered low-flow, comparison to flow measurements made by the USGS in 1987 indicated that streamflow in Harrods Creek can be considerably lower than that measured for this study. The USGS measured 0.54 cubic feet per second (cfs) on September 23, 1987, and 0.82 cfs on October 20, 1987, in Harrods Creek at the Highway 393 bridge (site 3), while 4.94 cfs was measured during this study. A flow of 1.13 cfs was measured by the USGS in South Fork Harrods Creek at the Highway 1694 bridge (site 4) on September 23, 1987, but was 3.14 cfs for this study.

Water Quality in Harrods Creek

Nearly 3 miles of lower Harrods Creek fails to meet Kentucky's minimum daily average dissolved oxygen standard of 5.0 mg/L (Figure 2, Table 3). Dissolved oxygen (DO) decreased from 11.0 mg/L at mile 12.3 to a low of 2.2 mg/L at mile 1.6. Dissolved oxygen increased to 3.4 mg/L at mile 0.2, while DO in the Ohio River near the mouth of Harrods Creek was 5.5 mg/L. Measurements plotted on Figure 2 were collected on July 10 over the course of the day. Those plotted from data in the backwater area were collected at mid-channel, at a depth of 5 feet. The Ohio River measurement plotted on figure 2 was also made at a depth of 5 feet. Profiles of dissolved oxygen and temperature were conducted on July 10 at several locations to determine variability throughout the water column (Table 4). Stations sampled in the afternoon exhibited DO stratification apparently resulting from photosynthesis in the upper 5 feet of the water column. The station at mile 1.5 was sampled both in the morning and late afternoon. only the afternoon sample exhibited stratification.

Dissolved oxygen concentrations in water are inversely related to temperature; the higher the water temperature, the lower the amount of oxygen that water can absorb. Because water temperature varied over the course of the study, it is useful to compare measured DO concentrations with the corresponding saturation points. Water with DO levels at saturation are in equilibrium; oxygen used in respiration and waste assimilation is balanced by oxygen production from algae and reaeration from the atmosphere. Water with DO above this point is supersaturated, which can be caused by swift riffles, waterfalls, and photosynthesis. Water with DO below this point is deficient, which indicates oxygen production and reaeration are insufficient to match oxygen demand. In streams this is generally the result of organic inputs. Table 5 presents the differences between measured DO and saturation values in Harrods Creek, which shows supersaturation in the upstream areas and large deficits in the backwater area.

Dissolved oxygen and temperature measurements made once per hour for 24 hours at four locations in the backwater area provided information on daily cycles. DO concentrations at mile 3.6, about 0.2 miles above the Hunting Creek South wastewater facility, were fairly stable and did not violate the DO standard at any time over the sampling period (Figure 3). A typical cycle of increasing levels during daylight hours and decreasing levels at night was not observed, probably because little photosynthesis was occurring at this location and depth. Temperature varied from 26.2 to 27.0 degrees Centigrade (^{o}C). Concentrations at mile 3.3, about

Fig. 2. Dissolved Oxygen Concentrations in Harrods Creek

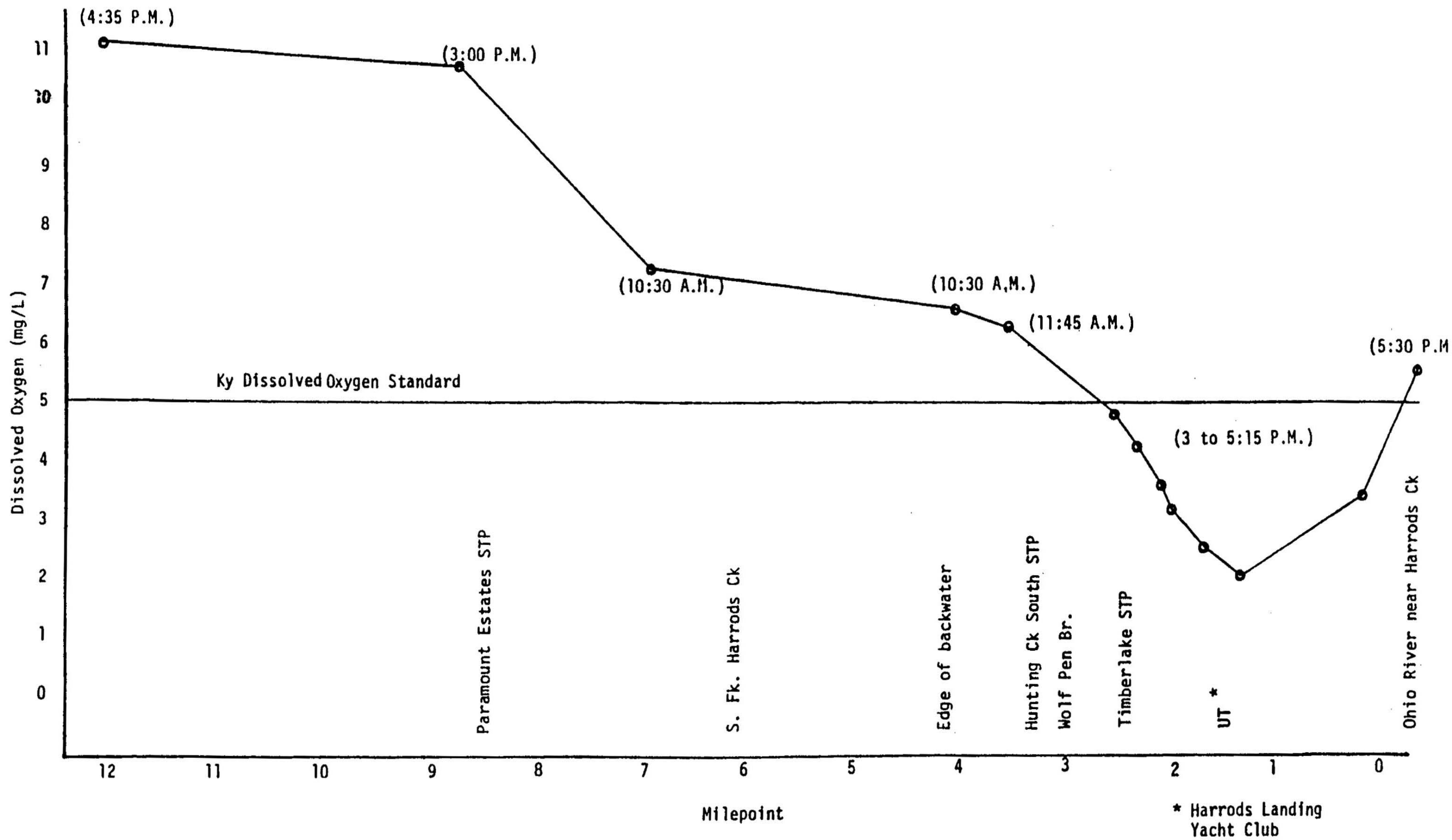


TABLE 3. WATER QUALITY CONDITIONS IN HARRODS CREEK

MAP #	STATION	DATE	TIME	FLOW (CFS)	DISSOLVED OXYGEN (MG/L)	WATER TEMP. (DEG. C)	CBOD 5-DAY (MG/L)	AMMONIA (MG/L AS N)	PHOSPHOROUS (MG/L)
1	HARRODS CK BELOW DARBY CREEK AT MILE 12.3	7-10-90	4:35 P.M.	2.67	11.0	29.5	1.3	<.05	.01
2	HARRODS CK ABOVE PARAMONT ESTATES AT MILE 8.9	7-10-90	3:00 P.M.		10.8	28.7	1.9	<.05	.009
15	PARAMONT ESTATES STP	7-10-90	3:30 P.M.	.002	8.2	25.0	5.1	.09	.67
3	HARRODS CK ABOVE S. FK. HARRODS AT MILE 6.9	7-10-90	10:30 A.M.	4.94	7.2	26.1	1.2	<.05	<.005
4	S. FK. HARRODS BELOW HITE CK AT MILE 1.4	7-10-90	11:45 A.M.	3.14	7.1	25.5	2.3	<.05	1.39
5	HARRODS CK, EDGE OF BACKWATER AT MILE 4.2	7-11-90	10:30 A.M.		6.6	24.4	1.3	<.05	.082
6	HARRODS CK ABOVE STP #28 AT MILE 3.6	7-10-90 7-11-90	11:45 A.M. 9:45 A.M.		6.3 5.5	25.0 26.4	1.4	<.05	.26
28	HUNTING CREEK SOUTH STP	7-10-90 7-11-90	12:30 P.M. 1:05 P.M.	0.15 0.14	7.8 7.4	24.4 26.0	1.4 2.6	<.05 .21	5.89 5.50
7	WOLF PEN BRANCH	7-10-90	2:00 P.M.	0.35	7.3	21.5	1.1	<.05	.02
8	HARRODS CK ABOVE STP #31 AT MILE 2.6	7-10-90 7-11-90	2:55 P.M. 1:15 P.M.		4.8 4.3	24.5	3.4	.07	.21

TABLE 3. WATER QUALITY CONDITIONS IN HARRODS CREEK (Continued)

MAP #	STATION	DATE	TIME	FLOW (CFS)	DISSOLVED OXYGEN (MG/L)	WATER TEMP. (DEG. C)	CBOD 5-DAY (MG/L)	AMMONIA (MG/L AS N)	PHOSPHOROUS (MG/L)
31	TIMBERLAKE STP	7-10-90 7-11-90	3:20 P.M. 1:30 P.M.	0.04 0.07	7.2 7.0	26.0 26.4	1.1 1.4	.19 <.05	5.29 5.99
	HARRODS CK 150 FT BELOW STP	7-10-90	3:50 P.M.		4.2	25.0			
	HARRODS CK AT MILE 2.3	7-10-90 7-11-90 7-12-90	4:00 P.M. 12:10 P.M. 9:20 A.M.		3.6 3.2 4.3	24.5 26.2 25.6			
	HARRODS CK AT MILE 2.1	7-10-90	4:20 P.M.		3.2	24.8			
	HARRODS CK AT MILE 1.7 ABOVE MARINA	7-10-90 7-11-90	4:25 P.M. 1:45 P.M.		2.5 2.1	25.5 27.0			
9	UNNAMED TRIB. ABOVE PUTNEYS POND	7-10-90	6:30 P.M.	0.32	7.4	25.8	1.1	.05	2.84
	HARRODS CK AT MILE 1.6	7-10-90	4:30P.M.		2.2	25.0			
10	HARRODS CK BELOW MARINA AT MILE 1.5	7-10-90 7-11-90	10:00 A.M. 4:40 P.M. 9:10 A.M.		2.0 3.3 2.5	25.0 26.0 27.0	2.1	.23	.13
11	HARRODS CK NEAR MOUTH AT MILE 0.2	7-10-90	5:15 P.M.		3.4	26.5	1.7	.08	.06
	OHIO RIVER NEAR HARRODS CREEK	7-10-90	5:30 P.M.		5.5				

Table 4. Dissolved Oxygen and Temperature Profiles in Harrods Creek

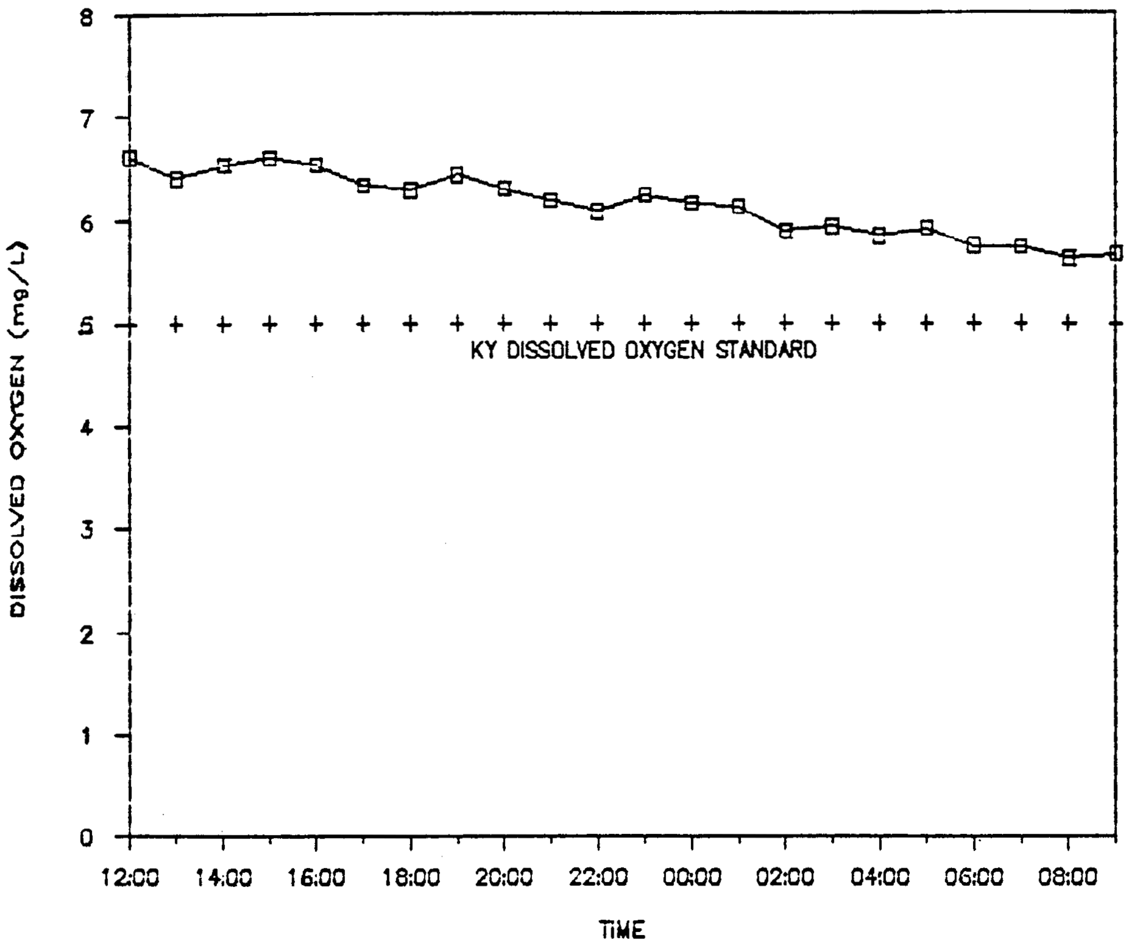
STATION	LOCATION IN CHANNEL	DEPTH (FT)	DO (MG/L)	TEMP. (DEG. C.)
HARRODS CK AT MILE 3.6 (11:45 A.M.)	Midstream	Surface	6.5	
		5	6.3	
		7	5.9	
HARRODS CK AT MILE 2.6 (3:00 P.M.)	Midstream	Surface	6.4	26.0
		5	4.8	24.5
		10	4.5	24.0
		14	4.4	24.0
HARRODS CK AT MILE 2.3 (4:00 P.M.)	Midstream	Surface	4.1	25.5
		5	3.6	24.5
		10	3.5	24.0
HARRODS CK AT MILE 1.7 (4:25 P.M.)	Midstream	Surface	5.2	28.0
		5	2.5	25.5
		10	1.8	24.8
HARRODS CK AT MILE 1.6 (4:30 P.M.)	Midstream	Surface	4.0	26.8
		5	2.2	25.0
		10	1.9	24.8
HARRODS CK AT MILE 1.5 (10:00 A.M.)	12 ft from bank	Surface	2.1	
		5	1.9	
	Midstream	Surface	2.2	
		5	2.0	
		10	2.0	
(4:40 P.M.)	Midstream	Surface	4.7	27.0
		5	3.3	26.0
HARRODS CK AT MILE 0.2 (5:15 P.M.)	Midstream	Surface	5.8	28.0
		5	3.4	26.5
		10	2.8	26.0
OHIO RIVER (5:30 P.M.)	Near mouth of Harrods Ck	Surface	7.5	28.0
		5	5.5	

Table 5. Dissolved Oxygen Deficits in Harrods Creek

HARRODS CK STATION	TEMPERATURE (Deg C.)	DO (mg/L)	DO SATURATION	DO DEFICIT
MILE 12.3	29.5	11.0	7.60	+3.40
MILE 8.9	28.7	10.8	7.65	+3.15
MILE 6.9	26.1	7.2	8.10	-0.90
MILE 4.2	24.4	6.6	8.35	-1.75
MILE 3.6	25.0	6.3	8.25	-1.95
MILE 2.6	24.5	4.8	8.35	-3.55
MILE 2.4	25.0	4.2	8.25	-4.05
MILE 2.3	24.5	3.6	8.35	-4.75
MILE 2.1	24.8	3.2	8.30	-5.10
MILE 1.7	25.5	2.5	8.20	-5.70
MILE 1.6	25.0	2.2	8.25	-6.05
MILE 1.5	26.0	3.3	8.10	-4.80
MILE 0.2	26.5	3.4	8.05	-4.65

DO Saturation values taken from QUAL2E USERS MANUAL, and rounded to nearest 0.05 mg/L.

Fig. 3. DO Concentrations at mile 3.6
(July 10 and 11, 1990)



500 feet below the facility, were lower than those at mile 3.6. and ranged from 5.0 to 6.1 mg/L (Figure 4). The increase in DO observed during the night of July 11 is probably the result of rainfall that occurred. The National Weather Service measured 0.29 inches of rain on July 11 and 0.24 inches on July 12 at Standiford Field in Louisville. Rainfall began in late afternoon on July 11. Temperature ranged from 24.7 to 26.7"C. The minimum daily average dissolved oxygen standard was not met during the entire period at mile 2.2, ranging from a low of about 3.0 mg/L to a high of 4.3 mg/L (Figure 5). This station also consistently violated the instantaneous minimum standard of 4.0 mg/L. The observed increase in DO over the sampling period is attributed to the rainfall on July 11 and 12. Temperature ranged from 25.9 to 26.8°C. Data collected at mile 1.5 exhibited a more typical curve, with an increase in DO in late afternoon and a decrease at night (Figure 6). Again, however, concentrations were less than the 4.0 mg/L standard for much of the period, ranging from 2.8 to 5.8 mg/L. Temperature varied from 26.6 to 28.20°C.

Water samples were analyzed for 5-day carbonaceous biochemical oxygen demand ($CBOD_5$), ammonia nitrogen, and phosphorous (Table 3). Concentrations of $CBOD_5$, and ammonia were very low at all 11 stream sites. $CBOD_5$ ranged from 1.1 to 3.4 mg/L and ammonia varied from less than 0.05 mg/L (the detection limit) to 0.23 mg/L. Effluent concentrations from the three treatment plants were also very low, ranging from 1.1 to 5.1 mg/L $CBOD_5$ and less than 0.05 to 0.21 mg/L ammonia. These effluent concentrations were much lower than expected, and are well below the facilityies permit limits. This high degree of treatment may be due to increased residence times within the facilities because they are currently operating at less than design flows. The Paramont Estates facility has a design capacity of 0.4 million gallons per day (mgd), but was operating at only .001 mgd when measured on July 10. This is a new subdivision that is not yet fully developed. Hunting Creek South has been approved to expand to 0.25 mgd, yet is operating at 0.09 mgd. The Timberlake STP is designed for 0.15 mgd but is operating at 0.04 mgd. Full design flows are expected to be realized as development currently under construction comes on-line.

Total phosphorous concentrations were variable, and lower in the free-flowing sections of Harrods Creek than the backwater area. Concentrations from the wastewater facilities are typical of domestic wastes, ranging from 5 to 6 mg/L. Levels in South Fork Harrods Creek and the unnamed tributary above Putney's Pond were high, and indicative of the waste-water effluent flowing into these streams. The flowing sections of Harrods Creek and Wolf Pen Branch, which is spring fed, had concentrations of 0.005 to 0.02 mg/L. Phosphorous

Fig. 4. DO Concentrations at mile 3.3
(July 11 and 12, 1990)

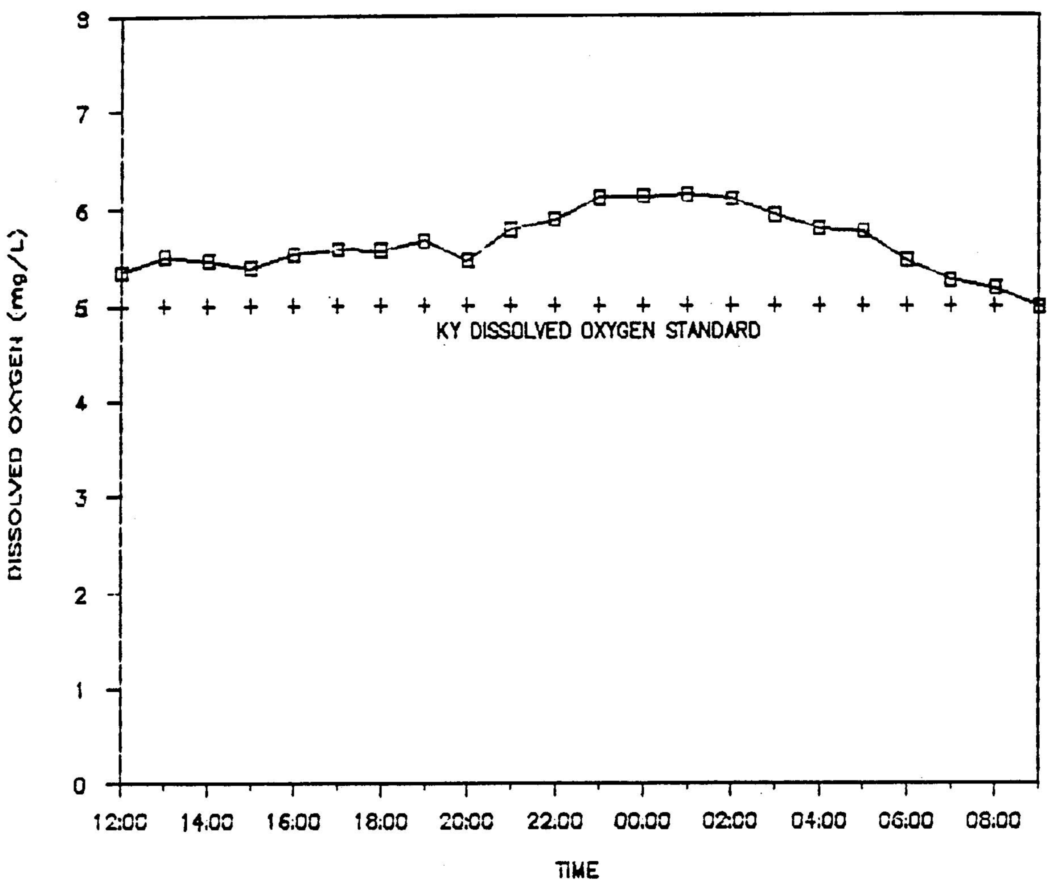


Fig. 5. DO Concentrations at mile 2.2
(July 11 and 12, 1990)

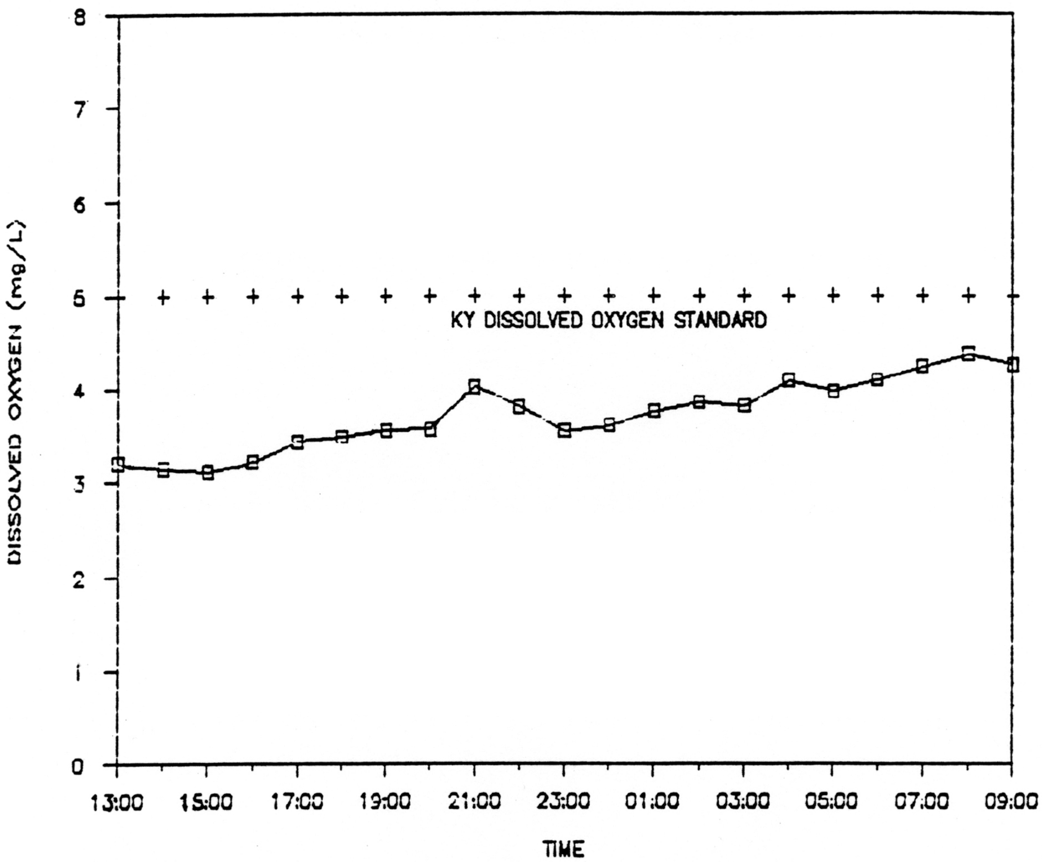
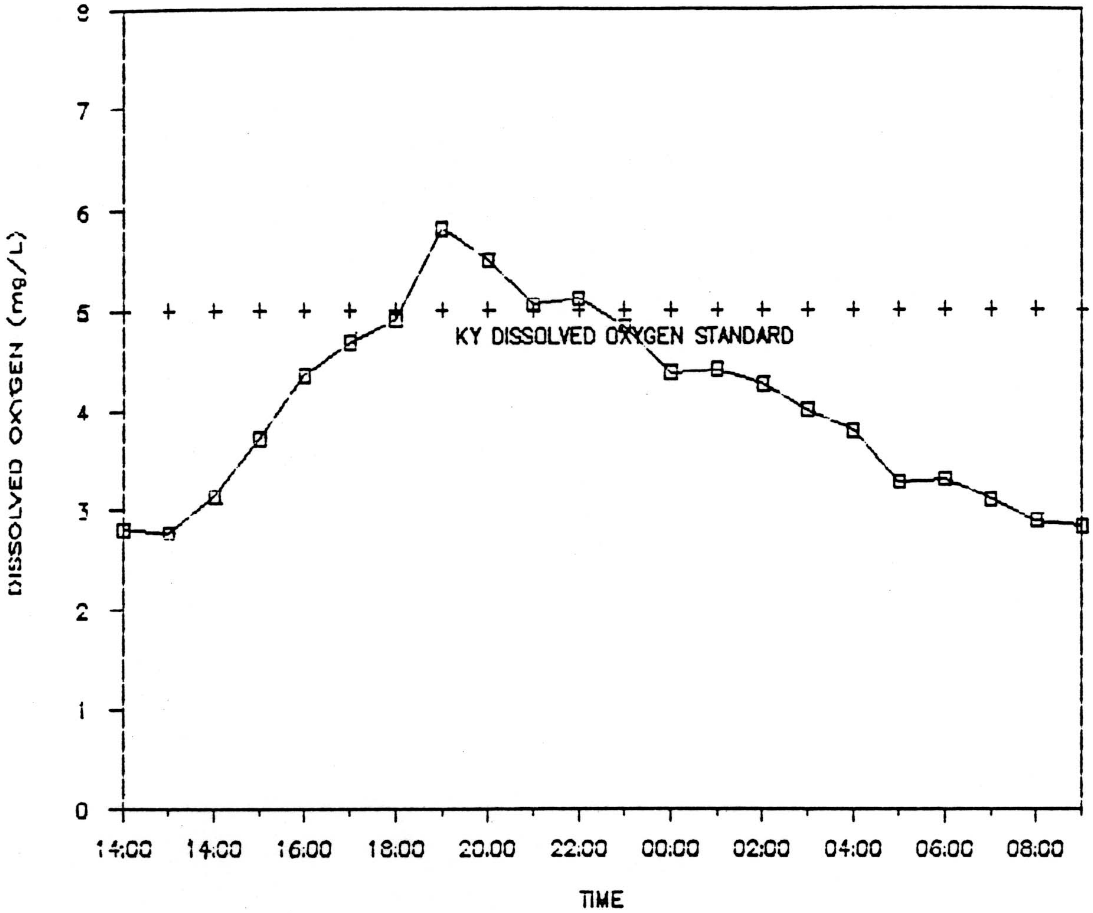


Fig. 6. DO Concentrations at mile 1.5
(July 10 and 11, 1990)

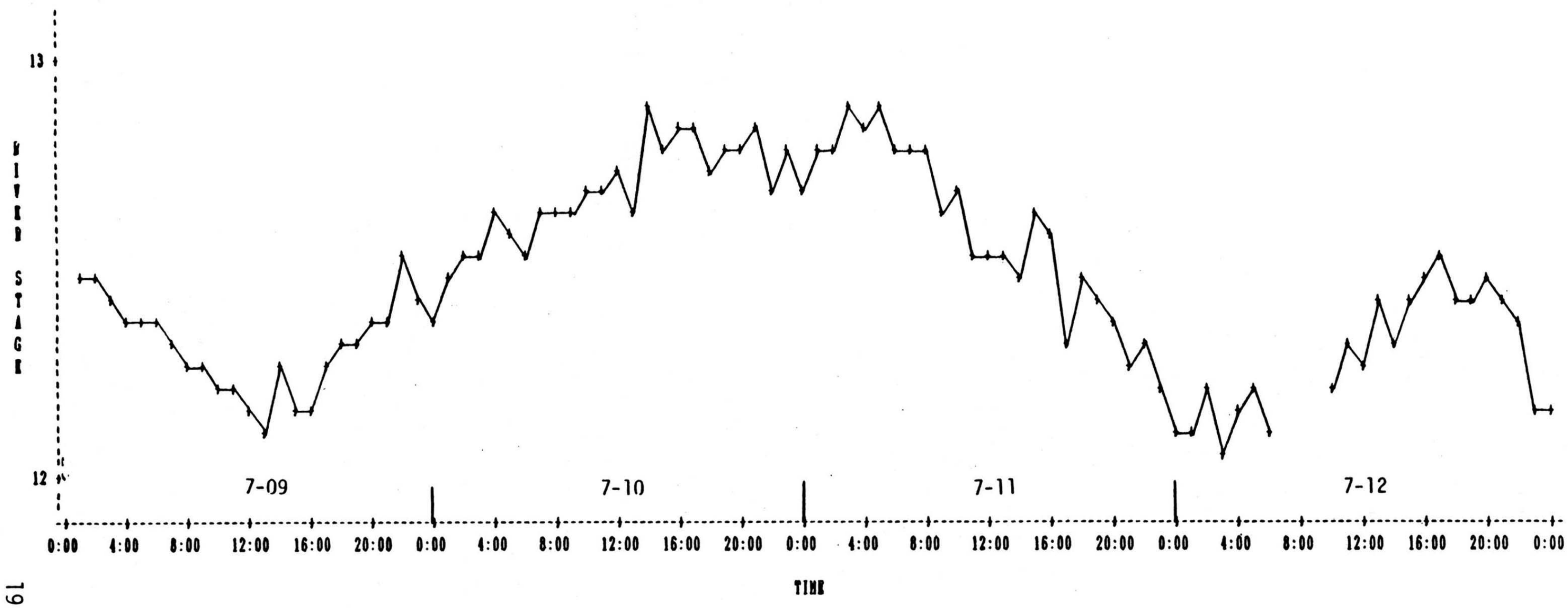


concentration in the upper edge of the backwater area was 0. 08 mg/L, ranged from 0.21 to 0.26 mg/L in the mid-reach of the backwater, and decreased to 0.13 mg/L at mile 1.5 and to 0.06 mg/L near the Ohio River. The U. S. EPA recommends a value not to exceed 0.10 mg/L in free flowing streams to prevent nuisance algal growths. No nuisance algal growth was observed during this study. This data indicates that most of the phosphorous is used by algae and/or settles to the bottom within Harrods Creek and a relatively small amount flows into the Ohio River. The utilization by algae was occurring primarily in the upper 5 feet, as evidenced by the dissolved oxygen profile data.

The field observations of hydrologic conditions also indicate that most of the wastewater effluents entering the backwater area during stable, low flow conditions travel very slowly downstream towards the Ohio River. For most of the study, the backwater area of Harrods Creek was apparently stagnant, with no visible or measurable velocity. At an incoming flow of about 3 cfs, a width of 60 feet and a depth of 10 feet, a calculated average velocity of only 0.01 feet per second would occur. At lower inf lows, such as those measured by the USGS in 1937, velocity would be even less. Surprisingly, twice during this study water was observed to be flowing upstream for a brief period of time, and three times was visibly flowing downstream. Several events might cause these observations. Conversation with the Corps of Engineers indicates the Ohio River experiences some flow perturbations occurring between the high lift dams as gates are raised or lowered, which could'also affect backwater tributary streams. Barge passage in the Ohio River might cause an upstream surge; however, no physical wave action was associated with the upstream flow. An increase in the level of the Ohio River might also cause water to back up into tributary streams. Downstream flow might be caused by a decrease in the level of the Ohio River, allowing water to move downstream. Hourly stage levels of the Ohio River at McAlpine Dam were obtained 'from the USGS and plotted (Figure 7). Stage levels are somewhat erratic, but show an overall increase on July 10, and a decrease on July II. A comparison of field notes to this stage data indicated that the Ohio River was falling during all three observations of visible downstream flow, and was rising during one upstream flow observation. The time of day of the other upstream flow event was not recorded, and thus could not be compared to stage data. The rise and fall of the Ohio River during these events was only 0.1 to 0.2 feet, and may or may not be the actual cause of the observations in Harrods Creek.

As noted, both the hydrologic observations and the phosphorous data indicate that wastewater effluents are primarily consumed within the backwater area during stable,

FIG. 7. OHIO RIVER STAGE DURING HARRODS CK STUDY
(MEASURED HOURLY ON JULY 09 THRU 12 1990)



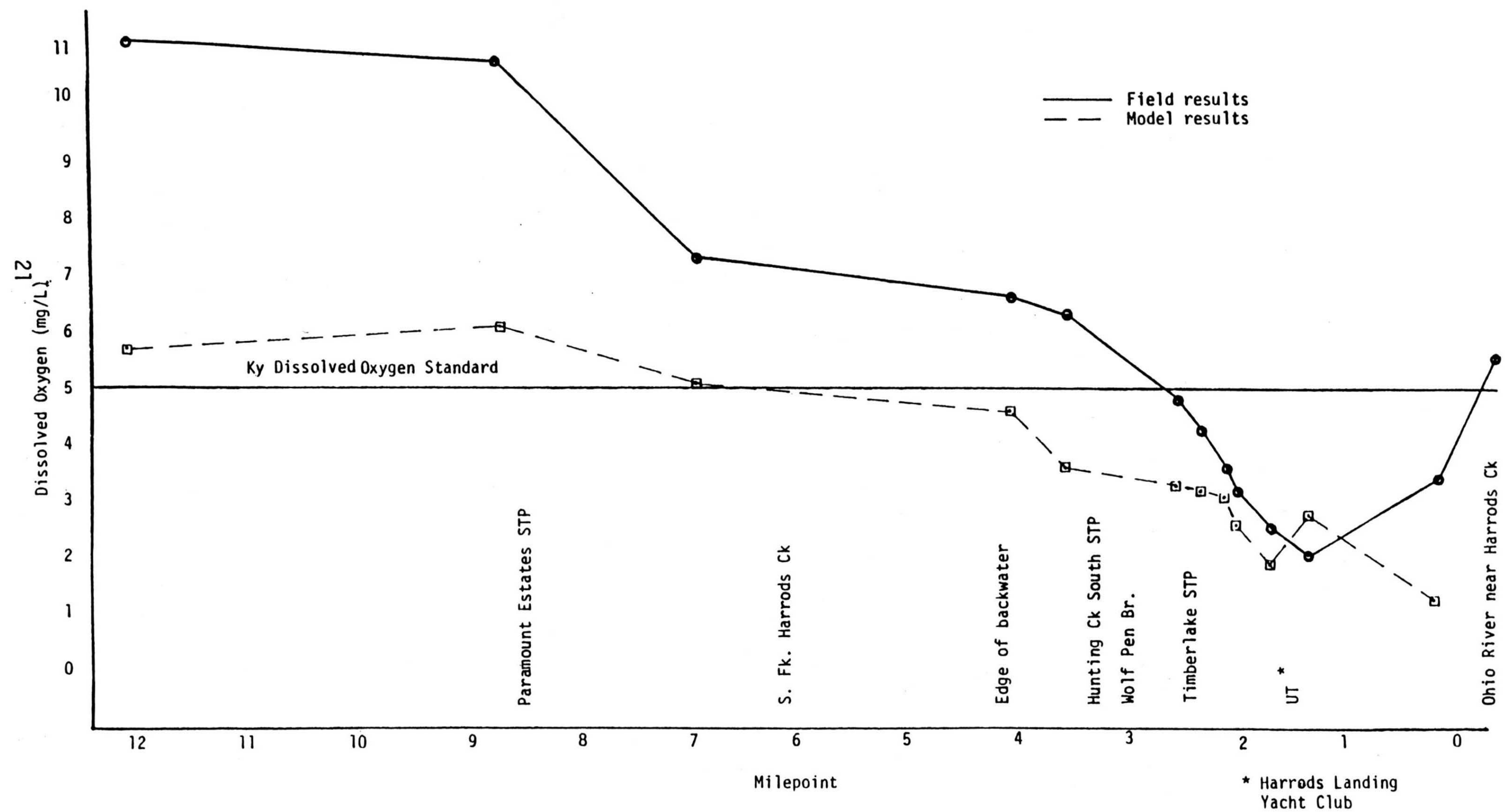
low-flow conditions. These effluents, even though of high quality, apparently overwhelm the assimilative capacity of the backwater area and are most likely the cause of the low dissolved oxygen concentrations measured in Harrods Creek.

Comparison of Field Results to Water Quality Model Results

Water quality modeling using U.S. EPA approved methodology is commonly employed by regulatory agencies throughout the United States to make permit decisions and set effluent limits for wastewater facilities. In October, 1988, updated information provided by the USGS was incorporated into the QUAL2E water quality model to simulate conditions in Harrods Creek during critical low-flow periods. One objective of the field study was to evaluate the reliability of using model results to make permit decisions in Harrods Creek.

Predicted dissolved oxygen concentrations from this modeling were plotted with the field concentrations measured during this study to assess model accuracy (Figure 8). There are two major differences between model input data versus measured field data, yet the results, especially in the backwater area, are very similar. Model predictions are based on input data that assumes low-flow conditions equivalent to the 7-day, once in 10 year (7QIO) occurrence interval, and wastewater facilities are assumed operating at design flow with effluent concentrations at the full level allowed by their permits. Actual field conditions measured during this study were significantly different. Measured streamf low into the study area was about twice that used for modeling, which is based on the USGS data collected in 1987. As previously noted, wastewater facilities are currently operating at much less than design flow, and thus have a higher quality ef fluent than required by permit limits. With these dif f erences, predicted DO concentrations from modeling would be expected to be lower than field measurements. This is precisely what has occurred and depicted on Figure 8. The pattern of change between model predictions and stream measurements are closely matched. The differences in predicted versus measured concentrations in the upper watershed are caused by photosynthesis occurring during the daylight hours when the field samples were collected, which is not accounted for in the model, and the large difference in the Paramont Estates wastewater facility's modeled design conditions versus its small actual contribution. As this fairly new development grows, its actual discharge is expected to approach design conditions. The difference in the plot pattern near the Ohio River is most likely the result of some mixing with Ohio River water, an effect that modeling does not consider.

Fig. 8. Comparison of Field Results to Model Results



Field hydrologic conditions measured from this study were next used as input parameters to the model in order to compare these predictions to measured values. Model results indicate DO violations in the backwater area, but predicted violations are not as severe as measured violations. The pattern of change again remained similar, however.

Based on this analysis, water quality modeling appears to be a reasonable tool for predicting dissolved oxygen dynamics during low-flow conditions. Modeling indicates that Harrods Creek will likely violate dissolved oxygen standards to a greater degree than what is currently occurring when approved wastewater facility expansions are completed and additional flow from developments currently under construction are realized.

Conclusions and Recommendations

Water quality data collected for this study and data collected by MSD and the USGS demonstrate that nearly 3 miles of lower Harrods Creek do not meet Kentucky's standard for dissolved oxygen. Water quality modeling indicates conditions will likely deteriorate further when streamflow conditions are lower than measured during this study and as wastewater facilities expand to their design capacities.

The Division of Water in the past few years has allowed expansion of several wastewater facilities in the lower basin, with the restriction of greatly reduced permit limits. The assumption was that expanded facilities, with more strict effluent requirements, would result in a net reduction of pollutant loads into the basin. Data collected for this study show this assumption is incorrect. Existing effluent concentrations are of much higher quality than expected, yet Harrods Creek continues to violate the DO standard. Expanded facilities will not be able to produce a better effluent than is currently discharged, thus loadings will increase, not decrease as earlier anticipated.

Areas of extensive backwater, such as Harrods Creek, do not assimilate wastewater as does a flowing stream. Elimination of wastewater discharges into lower Harrods Creek is essential if Harrods Creek is to meet water quality standards. The Division recommends implementation of MSD's North County Action Plan, which would extend sewer lines into the basin and eliminate the Hunting Creek South, Timberlake, Hunting Creek North, Ken Karla and Shadow Wood wastewater facilities. It is also recommended the plan boundaries be extended to include the Paramont Estates, Countryside Estates, and Covered Bridge facilities. Sewer lines should also be extended from MSD's Hite Creek facility to serve the Crestwood area, thus eliminating 11 existing facilities above Sleepy Hollow Lake. Effluent from Hite Creek travels over 5 miles before reaching the backwater area of Harrods Creek, and is considered beneficial because it is providing a steady inflow of high quality water.

Construction of new facilities or expansion of existing facilities in areas not meeting water quality standards cannot be approved, as required by Kentucky water quality regulations. The Division will therefore continue to deny proposals for new or expanded facilities that would negatively affect the quality of water in lower Harrods Creek.

References

(1) Buchanon, T.J., and Somers, W.P. Techniques of Water-Resources Investigations; Discharge Measurements at Gaging Stations, USCS TWRI Book 3, Chapter A-8, 1976.

(2) Bowie, G.L., W.B. Mills, D.B. Poreella, C.L. Campbell, J.R.Pagenkopt, G.L. Rupp, K. M. Johnson, P.W.H. Chan, and S.A. Gherini, Rates, Constants and Kinetics Formulations in Surface Water Quality Modelin, 2nd ed., EPA/600/3-85/040, U.S. Environmental Protection Agency, Athens, GA, 1985.

(3) Brown, L.C. and T.O. Barnwell, Jr., The Enhanced Stream WaterQuality Models QUAL2E and QUAL2E-UNCAS: Documentation and User Manual, EPA/600/3- 87/007, U.S. Environmental Protection Agency, Athens, GA, 1987.

(4) Driscoll, E.D. (E.D. Driscoll & Assoc., Inc.), J.L. Mancini(Mancini and DiToro Consulting Inc.), and P.A. Mangarella (Woodward - Clyde Consultants), Technical Guidance Manual for Performing Wasteload Allocations, Book 11, Chapters I & 2, .EPA-440/4-84-020, U.S. Environmental Protection Agency, 1983.

(5) Mills, W.B., G.L. Bowie, T.M. Grieb and K.M. Johnson (TetraTech.,. Inc.), and R.C. Whittemore (NCASI), Stream Sampling for Wasteload Allocation Applications, EPA/625/6-86/013, U.S. Environmental Protection Agency, 1986.